

Statement of

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and

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Impacts of the Fiscal Year 2007 Budget Proposal

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Mr. Chairman, Ranking Minority Member, and members of the committee: thank you for inviting me here to testify today. My name is Berrien Moore, and I am a professor of systems research at the University of New Hampshire and Director of the Institute for the Study of Earth, Oceans, and Space. I appear today largely in my capacity as co-chair of the National Research Council (NRC)'s Committee on Earth Science and Applications from Space.¹ The views expressed in today's testimony are my own, but I believe they reflect community concerns. They are also fully supported by my co-chair for the NRC study, Dr. Richard Anthes, President of the University Corporation for Atmospheric Research (UCAR) and President-elect of the American Meteorological Society.

As you know, the NRC is the unit of the National Academies that is responsible for organizing independent advisory studies for the federal government on science and technology. In response to requests from NASA, NOAA, and the USGS, the National Research Council has begun a "decadal survey" of Earth science and applications from space which is due to be completed in late 2006. The guiding principle for the study, which was developed in consultation with members of the Earth science community, is to set an agenda for Earth science and applications from space, including everything from short-term needs for information, such as environmental warnings for protection of life and property, to longer-term scientific understanding that is essential for understanding our planet and is the lifeblood of future societal applications.

The NRC has been conducting decadal strategy surveys in astronomy for four decades, but it has only started to do them in other areas fairly recently. This is the first decadal survey in Earth science and applications from space.

Among the key tasks in the charge to the decadal survey committee is the request to:

- Develop a consensus of the top-level scientific questions that should provide the focus for Earth and environmental observations in the period 2005-2020; and
- Develop a prioritized list of recommended space programs, missions, and supporting activities to address these questions.

Recognizing the near-term challenges likely for FY '06 and FY '07, the sponsors of the decadal study requested an examination of urgent issues that required attention prior to publication of the survey committee's final report, which was scheduled for publication in the fall of 2006. The committee's "Interim Report," "Earth Science and Applications from Space: Urgent Needs and Opportunities to Serve the Nation," was delivered to the sponsors and briefed to this Committee on 28 April 2005.²

In the Interim Report, we stated that the nation's "system of environmental satellites is at risk of collapse." That statement, which may have seemed somewhat extreme at the time, was made before Hydros and Deep Space Climate Observatory missions were

¹ <<http://qp.nas.edu/decadalsurvey>>

² National Research Council, *Science and Applications from Space: Urgent Needs and Opportunities to Serve the Nation*, The National Academies Press, 2005. <<http://www.nap.edu/catalog/11281.html>>.

cancelled; before the Global Precipitation Mission was delayed for two and a half years; before the NPOESS Preparatory Program mission was delayed for a year and a half; before the NPOESS program breached the Nunn-McCurdy budget cap and was delayed for at least several years, and before significant cuts were made to NASA's Research and Analysis account. In less than a year since our Interim Report was issued, matters have gotten progressively worse.

It is against this backdrop that I turn to the Committee's questions.

What do you see as the most serious impacts on your field of the proposed slowed growth in the Science Mission Directorate? Clearly, it would be better to conduct more science than less, but what is the real harm in delaying specific missions? At what point do delays or cutbacks become severe enough to make it difficult to retain or attract scientists or engineers to your field?

The most serious impacts on Earth Sciences of the proposed slowed growth in the Science Mission Directorate are the severe cuts in the Research and Analysis program. These cuts would be very damaging to the science and technology programs in the United States, particularly those at universities. We all know that our country is struggling to attract students to physics and mathematics. In the State of the Union address, President Bush proposed, "to double the federal commitment to the most critical basic research programs in the physical sciences over the next 10 years." The President's proposal was part of a larger effort to "encourage children to take more math and science, and to make sure those courses are rigorous enough to compete with other nations." In my view, the cuts to NASA's Research and Analysis program in Earth Science are at odds with these objectives.

The numerous mission cancellations, deferrals, and de-scoping that have occurred in the previous 2 budget cycles have already had a severe detrimental effect on NASA Earth science. The table below, which is taken from the Interim Report, shows just the effects of the FY '06 budget.³ I am concerned that the new cuts in the FY '07 budget, especially the significant reductions in funding for Research and Analysis, could have a devastating effect on a program already pared to the bone.

³ Ibid, page 17. Note that the Glory mission was subsequently restored. The latest plan for LDCM is to implement the mission as a free-flyer with a launch in 2011.

Canceled, Descoped, or Delayed Earth Observation Missions (from the April 2005 Interim Report of the Decadal Survey)

Mission	Measurement	Societal Benefit	Status
Global Precipitation Measurement (GPM)	Precipitation	Reduced vulnerability to floods and droughts; improved capability to manage water resources in arid regions; improved forecasts of hurricanes	Delayed
Atmospheric Soundings from Geostationary Orbit (GIFTS—Geostationary Imaging Fourier Transform Spectrometer)	Temperature and water vapor	Protection of life and property through improved weather forecasts and severe storm warnings	Canceled
Ocean Vector Winds (active scatterometer follow-on to QuikSCAT)	Wind speed and direction near the ocean surface	Improved severe weather warnings to ships at sea; improved crop planning and yields through better predictions of El Niño	Canceled
Landsat Data Continuity—bridge mission (to fill gap between Landsat-7 and NPOESS)	Land cover	Monitoring of deforestation; identification of mineral resources; tracking of the conversion of agricultural land to other uses	Canceled
Glory	Optical properties of aerosols; solar irradiance	Improved scientific understanding of factors that force climate change	Canceled
Wide Swath Ocean Altimeter (on the Ocean Surface Topography Mission; OSTM)	Sea level in two dimensions	Monitoring of coastal currents, eddies, and tides, all of which affect fisheries, navigation, and ocean climate	Instrument canceled— descope of an enhanced OSTM

For example, it is my understanding that approximately half of the NASA Goddard Spaceflight Center's workforce is made up of contractors. The proposed cuts across NASA for Research and Analysis funding are approximately 15%. In the Earth sciences, I am told that the cuts for FY '07 appear to be closer to 20% in key elements. Since Goddard cannot reduce its civil service workforce, this cut will be magnified by a factor of 2 on the contractor workforce. The current contractor workforce is about 300 people and thus up to 120 people could be let go. A similar impact is likely at universities, especially as NASA will have to pay its civil servants first. Research and analysis grants will be cut; members of the community are concerned that grants already awarded might be withdrawn.

Because of the nature of the competitive process, universities, industry, and NASA centers must invest significant internal funds to prepare proposals that are compelling scientifically. Prematurely cutting missions or research awards for non-technical or cost reasons or eliminating grants after they have been awarded will have permanent, damaging consequences. The scientific community is beginning to question the

reliability of NASA as a partner, and the wisdom of investing internal resources in the proposal development process.

Another impact is to reduce scientific research on missions that have already been launched and are providing novel observations of the Earth with unprecedented opportunities to learn about our planet. Cutting the research after all of the expense of building and launching the missions means that much of the up-front, and most expensive part of the mission will be wasted.

While I understand that NASA is facing difficult budgetary decisions, and priorities must be set, it would be a severe blow to NASA science to allow the R&A awards to be cut—especially given the already large investment in missions and the relatively low-cost, productive, and unique scientific understandings that result from these awards.

I shall return to this topic in answering your second question, but first let me address the other two components of the Committee's first question: the impact of mission delays and retaining or attracting scientists and engineers.

The impact of added delays are two-fold: 1) There will be increased costs downstream that will further undermine the possibilities for a revitalized future Earth science program, and 2) There will be continued negative impact on the morale of scientists within and outside of NASA. The importance of this impact should not be underestimated.

As this committee knows, procurement stretch-outs always increase overall program costs. Moreover, moving costs forward in time for current missions in development means that there is less "out-year" money for the future. Once again, we are mortgaging our future. In addition, delays often mean the penalties of missed synergies and gaps in observations associated with delay in execution.

For example, the 2-year delay in the Global Precipitation Mission (GPM) will create a gap between its operation and that of the Tropical Rainfall Measurement Mission (TRMM), whose science operations were extended last year in part because of their valuable role in meteorological forecasts of severe weather events. The delay of GPM also endangers a carefully planned partnership with the Japanese space agency, JAXA.⁴ Goddard will also be challenged to maintain a viable mission given a flat funding profile for GPM from FY '06 through FY08. Project scientists are rightfully concerned that the 2-year delay in GPM threatens the viability of the mission.

However, I am equally concerned about the impact of program delays on the morale of scientists within and outside of NASA and the health of the specialized workforce that is necessary to maintain core competencies. From personal conversations and anecdotal reports, the sense of gloom and discouragement is widespread, and this is obviously connected to your important question, "At what point do delays or cutbacks become

⁴ Among other items, JAXA is developing the dual-frequency precipitation radar that is at the heart of the GPM mission.

severe enough to make it difficult to retain or attract scientists or engineers to your field?" In my view, we are well past that point—the prior deterioration of the NASA Earth Science program, which was discussed in the Interim Report, has already had an adverse impact on our ability to attract scientists or engineers. This situation will only grow worse unless there are significant improvements to the FY '07 budget proposal.

Do you believe the decisions NASA has made concerning which missions to defer or cancel are consistent with the interim report of the National Academies Decadal Survey that you released? Given the FY '07 budget request, do you see any need to change the process for the next Decadal Survey?

The budget is inconsistent with the Interim Report. This is the real issue.

The Interim Report endorsed the Hydros Mission; subsequently but before the FY '07 budget was released, Hydros was cancelled. So was the Deep Space Climate Observatory, which was not addressed by the Interim Report, but had been supported by an earlier panel of the Academy.⁵ The Interim Report stated that the Global Precipitation Mission should "proceed immediately and without further delay." The NASA FY '07 action delays the mission by two and a half years.

The Interim Report not only recommended that NASA and NOAA complete the fabrication, testing, and space qualification of the atmospheric soundings from geostationary orbit instrument (GIFTS--Geostationary Imaging Fourier Transform Spectrometer), but it also recommended that they support the international effort to launch this instrument by 2008. While NOAA has completed some of the space qualification of GIFTS, the FY '07 budget does not provide the additional funding that would be necessary to complete GIFTS.

The Interim Report also asked for studies regarding linking of NASA missions and plans and the NPOESS program in several key measurement areas: ocean vector winds, atmospheric aerosols, solar irradiance. We also requested an analysis of the capabilities of the then planned NPOESS Operational Land Imager (OLI) to execute the LandSat Data Continuity Mission. We have not received these studies, though we recognize that events subsequent to the publication of our report have altered the circumstances for some of the requests. However, I believe that the need for such studies has increased given the budget challenges for NASA and NOAA, the delay, cost growth, and likely changes to NPOESS, and the delay and changing ideas for the development of an operational land imaging capability and implementation of the LDCM.

The Interim Report called for the release of the next Announcement of Opportunity (AO) for the Earth System Science Pathfinder (ESSP) program in FY 2005; we understand that the earliest AO for the next ESSP will be FY 2008.

⁵ National Research Council, *Review of Scientific Aspects of the NASA Triana Mission: Letter Report*, National Academies Press, 2000. <<http://www.nap.edu/catalog/9789.html>>.

Finally, in closing my April 2005 testimony before this Committee, I stated that the Decadal Survey Committee was “concerned about diminished resources for the research and analysis (R&A) programs that sustain the interpretation of Earth science data. Because the R&A programs are carried out largely through the Nation’s research universities, there will be an immediate and deleterious impact on graduate student, postdoctoral, and faculty research support. The long-term consequence will be a diminished ability to attract and retain students interested in using and developing Earth observations. Taken together, these developments jeopardize U.S. leadership in both Earth science and Earth observations, and they undermine the vitality of the government-university-private sector partnership that has made so many contributions to society.” Unfortunately, the FY ‘07 budget for Earth Science reflects cuts of 15% or more in the overall R&A program for Earth Science. We are headed in the wrong direction.

How should NASA balance priorities among the various disciplines supported by its Science Mission Directorate? Do you believe the proposed FY ‘07 budget, given the overall level of spending allotted to science, does a good job of setting priorities across fields?

As noted above, NASA’s science programs have already sustained deep cuts in the last two budget cycles. Exacerbating the cuts is the recent and not widely reported downward modifications to the Operating Plan for FY ‘06. These cuts, which were submitted shortly after the release of the FY ‘07 budget, make the proposed FY ‘07 budget cuts retroactive to the beginning of FY ‘06. The timing of the cuts makes their effect more severe; it also masks the magnitude of what is an enormous cut to the FY ‘07 budget (because the comparison of FY07 to FY06 is now made with new, reduced FY ‘06). Budget analyses that do not account for these recent changes leave the impression that the NASA Earth Science research budget is flat when in fact it has been decimated.

In response to the committee’s question above: Budget priorities at NASA must be balanced to reflect the highest priorities of the four decadal surveys. The scientific community recognizes that much will not be accomplished in our current budget environment, but we must seek to realize the highest priority elements. I strongly support the FY ‘06 Authorizing language charging the NASA Administrator “to develop a plan to guide the science programs of NASA through 2016.”

Let me conclude my testimony by stating my strong support, which I did publicly at the December 2005 meeting of the AGU, for the new leadership at NASA. I believe that the science community as a whole is also strongly supportive of the new leadership. However, NASA is now being directed to do more than is possible with the resources it has been given. I believe the health of science programs at NASA, which less than 3 months ago were said to be protected by a “firewall” from obligations to complete the ISS, develop the CEV, and return the Shuttle to flight, is in peril. Simply stated, given the NASA “bottom line” budget number and the “demands” of Station, Shuttle, and Exploration, there is far less room (\$3.1 billion less in the next 5 years) for science.

Further, one can be reasonably sure that the pressure on science to fund under-budgeted parts of NASA flight programs will only increase—few, if any, large and complex technology development projects come in under budget. While not the subject of this hearing, this situation begs for an honest appraisal of NASA’s portfolio, its priorities, and whether the Nation can afford to allow NASA science programs to languish.

I look forward to answering any questions you may have. Thank you.

Berrien Moore III

Berrien Moore III joined the University of New Hampshire (UNH) faculty in 1969, soon after receiving his Ph.D. in mathematics from the University of Virginia. A Professor of Systems Research, he received the University's 1993 Excellence in Research Award and was named University Distinguished Professor in 1997. Most recently, he was awarded the 2007 Dryden Lectureship in Research by the American Institute of Aeronautics and Astronautics (AIAA). He has served since 1987 as Director of the UNH Institute for the Study of Earth, Oceans and Space. To date, Dr. Moore has authored over 150 papers on the carbon cycle, global biogeochemical cycles, Global Change, as well as numerous policy documents in the area of the global environment.

Dr. Moore has served as a committee member of the NASA Space and Earth Science Advisory Committee, which published its report in 1986: "The Crisis in Space and Earth Science: A Time for a New Commitment." In 1987, he was appointed chairman of NASA's senior science advisory panel and was a member of the NASA Advisory Council. In May 1992, upon completion of his Chairmanship, Professor Moore was presented with NASA's highest civilian award, the NASA Distinguished Public Service Medal for outstanding service to the agency.

Dr. Moore has contributed actively to committees at the National Academy of Science; most recently, he served as Chairman of the Academy's Committee on International Space Programs of the Space Studies Board. In 1999, he completed his term as chair of the National Research Council (NRC) Committee on Global Change Research with the publication of "Global Environmental Change: Research Pathways for the Next Decade." Currently, Dr. Moore is a member of the Space Studies Board and is the co-chair (with Rick Anthes, President of UCAR) of an NRC decadal survey, "Earth Science and Applications from Space: A Community Assessment and Strategy for the Future."

Dr. Moore served on NASA's Earth System Science and Applications Advisory Committee from 1998 to 2002; he chaired National Oceanic and Atmospheric Administration Research Review Team from 2003 to 2005, and he served on the Advisory Board, School of Engineering and Science, International University of Bremen from 2002 to 2006. At present, Dr. Moore's professional affiliations include the following:

- Member, Board of Trustees, University Corporation for Atmospheric Research;
- Member, Advisory Council, Jet Propulsion Laboratory;
- Member, Scientific Advisory Board, Max Planck-Institute for Meteorology, Munich, Germany;
- Chair, Steering Committee, Global Terrestrial Observing System (United Nations Affiliate);
- Member, Board of Directors, University of New Hampshire Foundation;
- Member, Science Advisory Team - The National Polar- Orbiting Operational Environmental Satellite System (NPOESS/NOAA).

